



U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND

Challenges to Electrifying Defense Combat Systems

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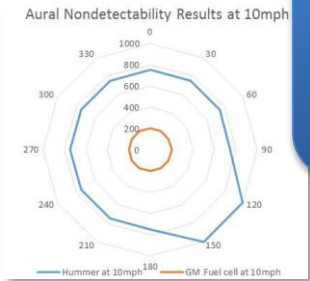
US Army RDECOM Tank-Automotive Research Development & Engineering Center



Operational Impact of Electrification

Reduced Signature

- 75%-90% Acoustic Improvement
- Thermal – Fuel Cells Run Cooler
- Remain undetected
- Place dismounts closer to objective undetected
- Enables new TTPs, ex: closer support by fire



Enables Improved Silent Off-Road Mobility

- Extended duration
- High Torque
- Greater Terrain Access
- Increases survivability



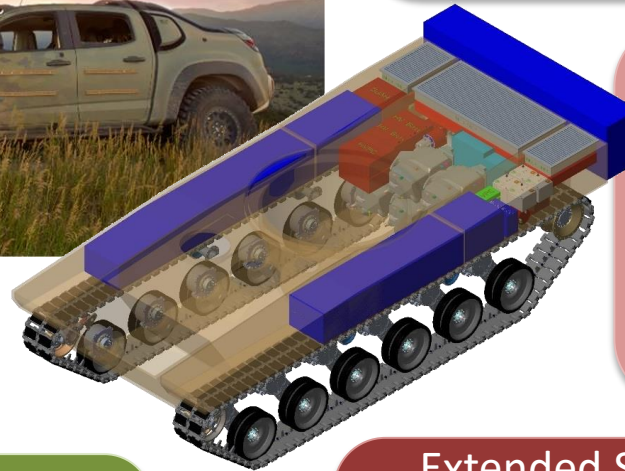
Enables Water Generation (Fuel Cell only)

- 800 kw = 53 gal water/hour
- Water at point of need
- Improves self-sufficiency



Extended Duration without Resupply

- Approx 72hr increase in ABCT endurance @ 70% combat power
- 50%-60% increased duration



Increased Onboard and Exportable Power

- Export up to 100% of on-board power
- Enables Directed Energy
- Eliminates need for tow behind generators
- Decreases TOC footprint

Extended Silent Watch (Fuel Cell)

- 15 kwh per kg of H₂
- 4x duration compared to current fielded batteries
- Enables undetected reconnaissance





Defense Electrification Challenges

Key Characteristics	Hybrid (Power Electronics)		All-Electric (Energy Storage)		Fuel Cell
	Power Density	Temperature Threshold	Capacity (300 mile range)	Charge Rate	Hydrogen Storage
Current / Army or Industry	3kW/L	85C Coolant	~0.15kW/L (best Li Ion)	100 kW	3.4MJ/L
Future Army Requirement	12kW/L	105C Coolant Engine coolant	0.60 kW/L	6 MW	13.6MJ/L
Improvement Required	4x *	24% *	4x **	60x ***	4x ****
Industry Gaps	High power density / high temperature power electronics a military unique requirement not being developed by industry.		High power / high energy / temperature a military unique requirement not being developed by industry.	Industry also desires fast charging. DOE leading effort to satisfy future military requirement.	Industry not investing in leap ahead military requirement.

* Silicon Carbide power electronics is the emerging capability.

** Beyond Lithium Ion energy storage is required.

*** 6 MW = ½ hour fill rate. Desired fill rate is ¼ hour = 12 MW.

**** Aluminum powder is most promising future technology.